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THE

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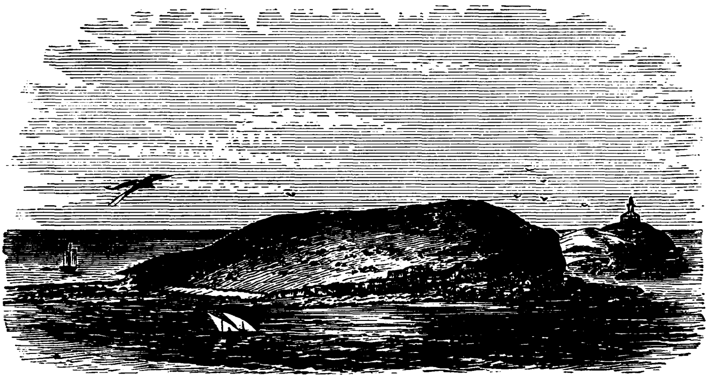
A NATURALIST IN BRAZIL.

BY C. FRED. HARTT.



SANTA BARBARA DOS ABROLHOS.

THE shore-line, where ocean and land meet, is rarely ever the edge of a continent. Both North and South America have a submerged border, in some places very wide, in others very narrow. Thus, off the coast of New England, the water does not deepen immediately at the shore-line, but the sea-bottom slopes off very gradually, sometimes, the water becoming ever deeper and deeper, until at a distance of many miles from the shore the true brink of the great valley occupied by the waters of the ocean is reached, and

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thence seaward the bottom slopes rapidly down beneath the almost unfathomable depths of the ocean. The walls of the continent do not arise perpendicularly from the ocean floor; they slope, to give greater strength and stability to the structure. As a general rule we know that the water which borders a low coast is shallow for some distance out, the sea-bottom continuing under water with the same general slope as the land. New Jersey is a State whose coast-lands are low and flat, and we find that the sea-bottom bordering it grows very gradually deeper and deeper, in such a way that the true edge of the continent, or of the ocean, properly speaking, lies at a distance of about eighty miles from the land. Just such a submerged border runs along the coast of Brazil, in some places being many miles in width, in others reduced to a very narrow strip; and we find the general rule holds good here as elsewhere, that the deeper water along the coast lies off the highest hills, while the flat lands are bordered by shallow water.

Professor Agassiz, in one of his New York lectures last winter,* showed how very strikingly alike North and South America are in their general and physical features. Not only is this true, but an examination of the eastern coasts of Brazil and the United States will show that there is a wonderful resemblance in the details of their geological structure. Thus, running all along the eastern coast of the United States, we find a range of mountains in which some of the oldest stratified rocks are upheaved, and on the eastern flank of these mountains, south of New York, are low lands occupied by more recent formations, thick beds of sandstone of the Triassic age and beds of marls, etc., of the Cretaceous; and over these, again, deposits of Tertiary and recent times.

I take a big Webster's dictionary, open it a little and stand it on edge with the covers sloping like the eaves of a house. This book I place before me in such a way that the line of the back will point towards the north-east. This will represent the Alleghany Mountains. Now I take a thinner book and lean its back against the south-eastern side of the dictionary so that it will slope off to the south-eastward, but very much more gently than the covers of the dictionary. This second book will represent much newer strata, which recline against those of the Alleghanies. Among those in New Jersey are thick beds of a coarse red sandstone, the material out of which brown-stone houses are so commonly made in New York City and elsewhere. Geologists call this Triassic or New-Red Sandstone. These beds have been tilted up since they were formed. Now let us take another book, and lay its edge just on that of the one last laid down, so that it will lie almost horizontally and much lower than the rest. This will represent newer strata, marls, and sands, etc., of Cretaceous age, which lie still undisturbed in the same position in which they were laid down. Take another book, and lay it so that its edge will overlap that last laid down, and this will represent beds of sands, etc., which were deposited after the Cretaceous, and which geologists call Tertiary strata. These are also undisturbed, and in the same position as that in which they were deposited. As we go southward, the Triassic rocks disappear from view, and the Tertiary beds lap over the Cretaceous, so as to bury them completely. All this will appear more plain from the following figure, which is an ideal section across the strata of New Jersey, from the mountains to the sea. *a* represents the upturned beds of gneiss, etc., of the mountains, against which lie inclined the Triassic, or New-Red Sandstone strata, *b*. Those marked *c* are Cre-

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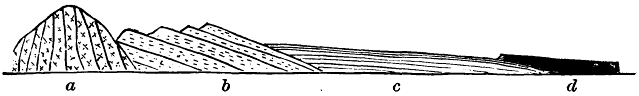
* Cooper Institute, February 5, 1867. In his lately published Journey to Brazil, Professor Agassiz has carried out this comparison between the two Americas to a much greater extent.

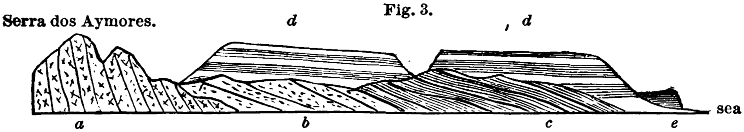
Fig. 2.



taceous, while *d* represents the latest deposited, or Tertiary beds. Now it is evident that the beds *a* are the oldest, and were the first disturbed. The Triassic rocks were deposited against them and slightly tilted up, and over these were laid down the beds of the Cretaceous and Tertiary.

If I make a similar section across the coast of Sergipe, a little province lying on the coast of Brazil just north of Bahia, from the gneiss hills to the sea, we shall find almost precisely the same structure, as is exhibited in the following section:—

Fig. 3.



a is the gneiss of the coast mountains, and is probably Azoic; *b*, beds of a coarse red sandstone, precisely like the Triassic, or New-Red Sandstone of New Jersey, and most probably of the same age; *c*, limestones and sandstones with fossils characteristic of the Cretaceous epoch, such as *Ammonites*, *Inoceramus*, etc., and *flint*. It is worthy of note, that whereas the Cretaceous strata of North America have suffered upheaval and folding only in the west, those of the eastern border of Brazil had been folded and disturbed prior to the deposition of the Tertiary strata *d*, which, occupying a higher level than on the east coast of the United States, everywhere lap completely over and bury the formations which occupy the lower grounds bordering the coast. Southward of New Jersey, as well as in the Mississippi valley, we also find the Cretaceous overspread by the Tertiary.

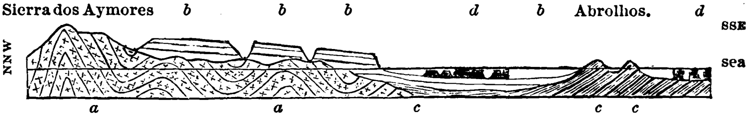
In this section *e* represents beds of sand containing shells, etc., of recent species, which have been raised above sea-level by the late, and probably now-continuing up-rise of the coast. Of this rising of the coast we have at Rio and elsewhere abundant evidence. One finds the nests excavated by sea-urchins in the rock, six feet or more above high tide-level. At Rio the upheaval amounts to about eight feet. In

North America the last great upheaval was greater in the north than in the south. Facts seem to show that in South America it was just the reverse.

About half-way between the cities of Bahia and Rio de Janeiro, and distant about forty miles from the mainland, there is a little group of islands, which, lying right in the way of navigation along the coast, and surrounded by dangerous reefs, have long been known as the *Abrolhos*, or "*Open-your-eyes*" Islands.

If we make a section across the country from the coast mountains, which separate the provinces of Minas Geraes and Bahia, to the sea, and then continue it to the Abrolhos, we shall have one like the following: —

Fig. 4.

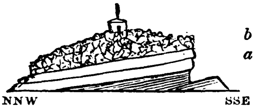


a, Gneiss; *b*, Tertiary strata; *c*, Cretaceous strata; *d*, Coral reefs.

In this section the New-Red Sandstone and Cretaceous beds do not appear on the main-land, at least so far as I have seen, and usually, as on the river Mercury, we find the Tertiary clays and sandstones lying immediately over the gneiss. But at the Abrolhos Cretaceous rocks appear, for the islands are seen to be composed of beds of shale, sandstone, etc., similar in character to those of the Cretaceous farther north. These islands stand about in the middle of the submerged border of the continent, which is here at least seventy miles wide. This submarine shelf is overspread by Cretaceous rocks, which, at the Abrolhos, have been broken and uplifted so as to form a little group of islands.

The Abrolhos consist of four principal islands, and two little islets. These are arranged close together in an irregular circle. All are quite high, the height of the principal one, Santa Barbara, being 33.22 metres (about 109 feet). This is the largest, and is three-quarters of a mile in length. On its summit is a very fine light-house, whose attendants, three men, are the only human inhabitants of the islands. The strata composing this island are inclined to the N. N. W., approximately, at an angle of 10°–15°, so that the island has a slope to the northward, while on all other sides it is precipitous. The surface is mainly composed of a bed of trap, which is spread out over the other rocks, as is seen in Fig. 5.

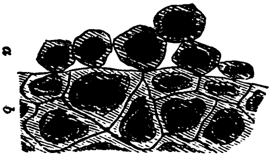
Fig. 5.



Section across island of Santa Barbara, Abrolhos. *a*, Shales and yellow Sandstones; *b*, Trap.

It is a wonderful thing to see how rocks decompose and rot away in Brazil. Even gneiss and slate grow soft to a depth sometimes of even a hundred feet. This trap-bed at the Abrolhos is decomposing also, but this takes place in a very interesting way. The trap, which is a very hard and heavy dark-bluish rock, is cracked up on the surface into angular pieces of all sizes, as represented in Fig. 6.

Fig. 6.



If the rock were smooth and unbroken on the surface, it would decompose only on the upper surface, but water soaks in through these cracks, and each fragment decomposes all around, so that a concentric coating of rotten rock is formed (Fig. 6, *b*), which may afterward be removed by rains. Thus each piece loses coating after coating like the layers of an onion, becoming ever more rounded in form as this goes on, until at last the surface of the bed is covered over with rounded boulder-like masses, often resembling cannon balls (Fig. 6, *a*). Nearly the whole surface of the island of Santa Barbara is covered by these rounded masses of trap.

The vegetation of the island is very scanty, and, save a *Siriba* on the island of that name, to which bear company two dwarf cocoa palms, trees there are none. Several species of coarse grass abound, and give sustenance on Santa Barbara to a herd of many hundreds of goats. There are some thickets of dwarf mimosas, and a few ferns, etc.

The land animals consist of lizards, of three or four species, which are considerably numerous. Insects are few, and the principal representative of the class is an immense hairy spider (*Mygale*), of a species very common on the coast. This spider, which the Brazilians call *Aranha caranguerja*, or *crab-spider*, has a body sometimes as big as an egg. It exists in countless numbers, living under stones. Almost every loose stone has one of these monsters under it. The bite from its long fangs is very painful and poisonous. It preys on lizards, and has been known to kill young chickens, and suck their juices.

Sea-birds resort here by myriads, at certain seasons of the year, to breed. Among these there are several species of gulls, pilots, and the magnificent frigate-bird. To these birds and their habits we may, perhaps, by and by devote a special paper.

It is in the waters of the vicinity, however, that the greatest riches of animal life are to be found. Fish, of an incredible number of species, are wonderfully abundant, and a regular fishery is carried on here from the town of Porto Seguro for a giant perch called the *Garoupa*, which fish is however cured so badly as to be scarcely eatable.

In the month of May, a species of whale (*Megaptera*) makes its appearance on this coast in considerable numbers. It is furnished with whalebone, and has on the back a hump of fat which looks very much like a fin. Above, it is black in color; below, usually white, or light-colored, and marked by longitudinal furrows, which are especially conspicuous under the throat. Along the lower jaws there is a number of round lumps, or tubercular masses of fat, as large as one's fist. The pectoral fins are long, narrow, and irregular along the edges. This whale grows to be thirty to forty feet in length.

Among the first to make their appearance at the commencement of the season are large females (*Madrijos*), bringing with them their little ones but just born. The whalers say that they resort to the islands and reefs for protection. The males are not so numerous, nor are they so valuable to the whaler. I once saw a female swimming with its calf. The latter swam close alongside its mother, following all the motions of the latter, and coming up to breathe at the same moment. The whalers all told me that the female holds out her fin obliquely, and that the little one swims with its head between it and the body. They denied that this whale ever clasped the young under the fin. This species is very lively and difficult to catch, notwithstanding which a small fleet of boats stationed at Caravellas captures every year some thirty to seventy whales, which afford a large quantity of oil. These two fisheries, that of the *Garoupa* and whale, deserve attention on the part of American fishermen, as they might be developed so as to become very profitable. The whales leave the coast in the latter part of September or in the early part of October. They occur also all along the Brazilian coast, but Bahia is the only other place at which they are systematically fished. Considerable numbers are caught here every year, and, during the season, one may sit at his breakfast at the restaurant in the hotel in the upper town, and watch the pursuit and capture of one of these monsters in the bay, almost under his very window.

It has long been known that the waters of the Abrolhos and vicinity were made very dangerous to navigation by extensive reefs, which covered large areas just outside of the islands, as well as between them and the main-land. In the descriptions of the Brazilian coast in the various "Coast Pilots," both English and foreign, that I have seen, very conflicting statements are made with reference to these reefs, some saying that they are composed of coral, others of decomposed gneiss; and the different kinds of reefs are confusedly described, so that it is not easy to distinguish, from these descriptions, reefs of rock, reefs of coral, or solidified beaches, like that of Pernambuco, which last, being separated from the land by the washing away of the loose sand of the upper part of the beach, as well as from behind, are left standing like walls of sandstone running parallel to the coast. In scientific books it is generally stated that there are no coral reefs on the coast of Brazil.

While engaged in the late Thayer Expedition under Professor Agassiz, in company with Mr. Edward Copeland, the writer discovered some quite extensive reefs in the bays of Santa Cruz and Porto Seguro, and made out, in a general way, their structure. Fishermen and pilots described the reefs of the Abrolhos as precisely like those at Porto Seguro, and a note in a chart of Lieutenant Mouchez, which afterwards fell into the writer's hands, left no doubt of the existence of extensive coral reefs in that region. The return of the Expedition left no time for their exploration, but the writer, during his visit to the Brazilian coast last summer, gave them a careful examination.

Many species of polyps grow along the coast of Brazil, even as far south as Cape Frio, and the bay of Rio offers a few insignificant coral building species, principally an *Astrangia* or two, which form scattered cells on dead shells or stones. There is at Rio quite a number of species of soft-bodied polyps, of the order of the *Sea-anemones*, and some of these are very beautiful. In the same bay representatives of the highest order of polyps, the Halcyonoids, are not numerous. The most interesting is a species of Renilla (*R. Danæ* Verrill),* a curious "family" of polyps, in which all the bodies of the animals are joined together, and clustered on one side of a leaf-like expansion, to which there is a single appendage like a stem, by which the whole moves about like a single individual.

South of Rio de Janeiro there appear to be few polyps which have calcareous skeletons; but on the rocky shores northward a few species soon begin to become quite common.

***I am indebted to the kindness of my friend, Professor Verrill, for the determination of the Radiates mentioned in this paper.**

In the rocky tide-pools of Os Busos, Guarapary, Victoria, Porto Seguro, etc., to Bahia, we find them quite abundant. There is a massive kind growing in rounded, flattened lumps or patches on the rocks belonging to the genus *Siderastræa.** It has small, close-set cells, and grows in masses often a foot or more in diameter, and occasionally several inches in height, encrusting the rocks. With this there occurs a little, irregularly globular coral, an inch or two in diameter, and with large, irregular, crowded cells, in which the radiating plates are very conspicuous (*Favia*, like *ananas* Edw. and Haime). In deeper water we find a large *Acanthastræa* (*A. Braziliensis* Verrill)† growing sometimes in round heads a foot or more in diameter, together with large bouquet-like masses, often a foot across, of a beautiful coral (*Mussa Harttii* Verrill),‡ whose branches, thick and long, are cylindrical, forking, radiating from the same point, and with the cells at the ends of the branches large and deep. There are several other species of hard limestone building corals. *Millepores*,* corals often with flat, ragged-edged branches, like the antlers of an elk, and with very small pores like pin-holes, are not uncommon.

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* *Siderastræa stellata* Verrill sp. nov. Corallum forming rounded or hemispherical masses, often flattened above. Cells polygonal, rather large (about .15 inch) deep, the central part rapidly descending. Septa in four cycles, those of the first two cycles considerably broadest, all of them evenly crenulated, rather thin, thickness less than the intervening spaces, slightly projecting, the inner edge evenly rounded. Columella inconspicuous, represented only by one or two tubercles. Wall between the cells represented by a simple line. Trabicular processes between the septa very distinctly seen from above. Differs from *S. radians* in having larger cells, which appear more open; thinner septa, and consequently wider intervening spaces, and four complete cycles of septa. — A. E. V.

† *Acanthastræa Braziliensis* Verrill. A large species, forming hemispherical masses a foot in diameter; margin of base surrounded by a strong epitheca; cells large, varying from .3 to .7 of an inch in their largest diameter, but mostly about .5 inch, irregularly polygonal, often much elongated, and then having two or more centres, moderately deep (.15 inch), centre depressed, columella but little developed. Septa thin, in fine cycles, the last usually incomplete, projecting subequally, the upper part divided into from three to five long, sharp teeth, below which the teeth are smaller and more slender. Walls between cells sometimes single, often double with vesicles between. — A. E. V.

‡ *Mussa Harttii* Verrill. A beautiful species, forming large clumps with rather small branches, and simple, subcircular cells. Branches rapidly dividing, mostly .5 to .8 of an inch in diameter, the living part extending from .2 to .5 of an inch from the summits, and often surrounded by an imperfect epitheca, covered with strong, subequal costæ, with numerous sharp, nearly equal, recurved spines. Cells from .5 to 1.2 inches in diameter, subcircular, often irregular, with waved margins, rather deep (.4 to .5 inch). Septa in five cycles, thin, subequal at summit, where they project about .1 of an inch, the upper part divided into from four to seven unequal, sharp, diverging teeth, with

In many localities south of the Abrolhos district, these corals grow quite abundantly, but I have no evidence that they ever form reefs or banks. Reef-building corals, according to the best authorities, flourish only at depths less than one hundred feet. They also require a warm temperature of the water. The great shelf of the Abrolhos lies over a very large area, at a depth of less than a hundred feet, and the conditions for the growth of corals are of the most favorable kind. In consequence of this, we find here not only around the islands, but in the shoal, open waters, very extensive reefs and banks, which, in an area of fifty miles square, occupy a space of nearly one hundred and fifty square miles.

When the tide goes out, there is seen extending around about one half the island of Santa Barbara, as is shown in the illustration at the head of this article, a fringing reef of coral, out on which one may walk, as on a low wharf at high tide, and from its ragged edge look straight down through the limpid green water, and see the sides of the reef and the sea-bottom covered with huge whitish coral-heads, and a wealth of curious things not easily to be got at.

The surface of the reef is quite flat, and rises but a short distance above low-water mark. It is rather irregular, and is overgrown with barnacles, shells, mussels, and serpula-tubes, and overspread with large slimy brownish patches, of

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smaller teeth below. Columella slightly developed, consisting of slender, loosely arranged, contorted processes.—A. E. V.

*The most abundant species is *Millepora nitida* Verrill. A very distinct species, forming low, rounded clumps, four to six inches in diameter, consisting of short, rapidly forking, rounded, or somewhat compressed branches, about .4 to .8 inch in diameter, which have a remarkably smooth surface, and are obtuse, rounded, or even clavate at the ends. The larger pores are small, very distinct, round, evenly scattered over the surface, at distances of about .06 to .1 of an inch apart. The small pores are minute, numerous, scattered between the large ones, and often showing a tendency to arrange themselves around them in circles of six or eight. The tissue is more compact and firmer than in *M. alcicornis*.—A. E. V.

a soft-bodied, encrusting polyp (*Corticifera*), of a leathery color.

The reef abounds in small pools, some of which are shallow and sandy, others deep, rocky, and irregular. The former often contain scattered corals, *Siderastræa* and *Favia*, and are rich in small shells, crabs, *Ophiuræ*, etc., but the latter are the most interesting.

Fancy, my reader, a pool of the purest sea-water held in an irregular rock-basin a few yards across, full of little grottoes and niches, and three or four feet deep. Carpet this pool with white coral sand and broken shells, and tapestry heavily the sides with soft fringes and curtains of delicate, brilliant-hued sea-weeds. Plant here and there on the rocks clumps of corals and sprigs of *Gorgoniæ*, and down deep in this shady corner place a big hemispherical Astræan. Here among the sea-weeds, and just out of reach of the sunbeams, let us plant two or three softly-tinted sea-anemones, just where the translucent, tender, petal-like tentacles of these sea-flowers will be best shown off. And we must not forget to stock our aquarium with a plenty of sea-urchins, pincushiony little monsters, bristling all over with long dark purple spines (*Echinometra Michelini* Desor), and each nestled comfortably away in a cavity worn in some incomprehensible manner in the solid rock. Here is a little crimson star-fish (*Echinaster*) ;* let us half hide him in under the sea-weeds, for it won't do to make him too conspicuous; and here are some queer crabs, that go restlessly prying about among the sea-weeds, frightening the sea-anemones, and, perhaps, falling a prey to a snaky-armed cuttle-fish, that lurks under some dead coral. Now we must introduce a swarm of little, gaily-painted, gilded and silvered fishes, and a crystal jelly-fish; a host of little shells, half of them tenanted by hermit-crabs, and swarms of little crustaceans. Now we will wreathe in among the sea-weeds, here and there, the necklace-like, pearly body of a marine worm, and we shall then have an aquarium, wonderfully like those which nature has so liberally strewn over the surface of the Brazilian coral-reefs.

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* *Echinaster crassispina* Verrill. Rays short, somewhat angular. Radius of disk .5 of an inch; of rays 1.9. Spines along each edge of the ambulacral grooves in two rows, the outer ones large and sharp, crowded, those on opposite sides crossing one another, a single one on each plate. Spines of inner row much smaller, not half as long, one to each plate. Lower side of ray with a row of distant, large, conical, sharp spines, not extending upon the disk. On back and side of rays there are four or five other irregular rows of similar large, sharp spines, rising from the swollen nodes. It has shorter and more angular rays, coarser structure, larger and fewer spines than *E. spinosus* of West Indies.

Under the dead corals one finds great numbers of a large *Ophiura*, with a small disk-shaped body, and long snaky arms (*O. cinerea* Lyman), and by dint of a little patient examination, with the aid of a pocket lens, he may collect hundreds of species of animals from one of these pools alone. At the Abrolhos Islands, I found a few specimens of a large, almost pentagonal starfish, which is very common in the West Indies (*Oreaster gigas* Lütken). This also occurs at Bahia, together with a very well-known West Indian shell, quite common as a mantel-piece ornament, and which has the misnomer of *Cassis Madagascarensis!*

The corals, which go to make up the Santa Barbara reef, are principally *Acanthastræa*, *Heliastræa*, *Siderastræa*, *Favia*, *Porites*, *Millepora*. The reef-rock, like that of the reefs, is a compact, hard, white limestone, which appears to show scarcely any organic structure. The corals are so broken and cemented together, that their structure is quite obliterated. The Santa Barbara reef, then, forms a wharf-like structure, partially surrounding the island. It has grown upward as far as possible, *i. e.* to a level a little above that of low tide, when the corals having died, further growth is stopped. It varies much in width, but in some places it reaches even 400 feet. At the south-west extremity of the island there is a little islet, composed of a pile of boulder-like masses of trap, and known as the "Cemetery," which at low tide is united to the main-land by this reef. A reef of the same kind is formed around part of the neighboring island of Redonda, and Siriba also has one.